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ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/yths20

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To cite this article: Christopher C. H. Cook (2020): The causes of human sexual orientation, Theology & Sexuality, DOI: 10.1080/13558358.2020.1818541

To link to this article: https://doi.org/10.1080/13558358.2020.1818541

Published online: 16 Sep 2020.

THEOLOGY & SEXUALITY
https://doi.org/10.1080/13558358.2020.1818541

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The causes of human sexual orientation

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ABSTRACT

Research on the causes of human sexual orientation has been marshaled in support of predetermined and opposing theological viewpoints. Whilst acknowledging that there is still much that is not known, the peer reviewed scientific literature clearly shows that a combination of genetic and environmental factors contribute to sexual orientation, with approximately one third of variance currently attributed to the former. Much of the known environmental influence appears to be intra-uterine and there is no currently convincing evidence that social environment plays a significant part. This body of evidence is relevant to theology. Greater attention should be given to critical interdisciplinary engagement of the theology and science of sexual orientation.

KEYWORDS

Sexual orientation; homosexuality; genetics; environment; theology; nature

Introduction

Scientific research on the causes of human sexual orientation might reasonably be said to have elicited more controversy than it warrants. Claims, for example, to have been "born gay" gloss over the scientific complexities, and evoke strong reactions for political, moral and theological reasons which easily obscure the scientific consensus on what is (and isn't) known. Research methods applied to the study of nature and nurture in human sexuality are in most cases similar or identical to those applied much less controversially to other psychological traits and behaviors. Such research has its limits and ongoing debates, but there is much that can now be positively affirmed on the basis of the available evidence.

The lack of evidence or consensus pertaining to some of the relevant questions has been taken by some as a basis for arguing that science does not inform the moral or theological arguments.[1] There are in fact good reasons for thinking that what we do know may have relevance to the theological and ethical debates. I shall return to considering these reasons at the end of this article. At this point, it is important simply to note that an understanding of homosexuality as a normal variant of human sexuality is currently taken as the basis for the ethical stance of many professional organizations.[2] A scientific understanding of the causes of this variation helps to clarify the basis for that ethical stance.

It is important to state at the outset that this article is not about the causes of homosexuality in isolation. Because gay and lesbian people are in a statistical minority, it is

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easy to ask questions such as "Why am I gay?" or "Why are *they* different?" In reality, the question of why most people experience heterosexual attraction, and others mainly or exclusively homosexual attraction, is all the same scientific question. Why are some of us (gay men and straight women) sexually attracted to men, and others of us (gay women and straight men) attracted to women? What is it that orientates our sexual attraction to others?

The present article will briefly review the scientific evidence on the causes of human sexual orientation and will then seek to identify some of the areas that may warrant further theological attention. In reviewing the scientific evidence, I am pleased to acknowledge a number of other critical reviews which I have drawn upon in the course of this work, and especially the work of Michael Bailey and his colleagues.[3] In seeking to identify points of theological relevance, I will not be planning to address these in depth, but rather to propose that the science raises theological questions that deserve fuller exploration than they have hitherto received.

Terminology

Science proceeds by way of defining terms and concepts that are amenable to empirical research. However, it also receives terms from common discourse which then need to be broken down and translated into scientific terminology in order to enable research to be undertaken. Scientific terms are not necessarily the same as those that are used in ordinary conversation, or that people would prefer to use in reference to themselves. The area of human sexuality is especially complex in this regard and many clinical reports include glossaries of definitions which seek to promote clarity about vocabulary.[4] Any review of scientific research on sexual orientation therefore needs to begin with clarity of terminology.

The term "gender" will be reserved here primarily for reference to the social roles associated with male, female, or other, gender identity. Gender is construed differently in different social and cultural contexts. Gender identity is thus socially and culturally situated. In fact, concepts such as homosexuality are also understood differently in different cultures (or else are not recognized at all) and thus sexual identity (defined on the basis of sexual orientation) is also to be understood in social and cultural context.

Sexual orientation refers to the predominant focus of sexual attraction. Sexual orientation is usually construed in terms of attraction to the same or opposite sex, or either/both, and thus as homosexual, heterosexual or bisexual respectively. An alternative approach is to construe sexual orientation in terms of attraction to male or female, thus as androphilic or gynephilic respectively, without reference to the sex/gender of the person experiencing the attraction. In some ways, as will become clear, this is a scientifically preferable approach.

Different studies of sexual orientation have variously attended to reported measures of sexual attraction, sexual identity, or sexual behavior. In some cases, albeit rarely in the research reviewed here, sexual arousal has been studied using objective physiological measures. Such methodological differences are clearly significant. Sexual attraction is now considered to be the state-of-the-art way of quantifying sexual orientation.[5] Much of the research defines sexual orientation operationally in terms of how people report their experiences of sexual attraction, commonly employing instruments such as the

Kinsey scale.[6] Sexual attraction has its more objective (physiological) and subjective (psychological) components.

Whilst people can choose to have sexual relationships (or not) with others, and can perhaps[7] choose to adopt a particular gender or sexual identity socially, they cannot choose their sexual orientation as defined in terms of sexual attraction or arousal. Sexual orientation in these terms generally appears to be a stable trait,[8] which is resistant to intentional efforts to change,[9] and is determined before birth, or perhaps early in life, by certain biological and environmental factors (to be discussed below). However, there is evidence that some women experience changes in sexual orientation over the course of a lifetime[10] and that women's experiences of sexual attraction are more malleable and context dependent than men's.[11]

Research suggests that men experience more category specific attraction/arousal than women. That is, attraction is specific to a particular sex/gender category. Thus, homosexual men are aroused by other men and heterosexual men are aroused by women. For women, attraction and arousal appear to be less category specific. Heterosexual women, for example, may show arousal in response to both male and female stimuli. Sexual fluidity, in contrast to category specificity, refers to the contextual factors whereby a woman (or, more rarely, a man) may find themselves attracted to either men or women in particular situations or circumstances.[12] In general, men seem to be much more category specific in their sexual orientation. Women are more likely to demonstrate sexual fluidity.

Evidence for sexual fluidity is sometimes taken as a reason for questioning whether or not there is any such thing as sexual orientation and whether it is meaningful to talk about "homosexuality". The leading researcher in this field, Lisa Diamond, is clear that this is not her view. More importantly, it does not represent the reported experience of her research subjects.[13] There are also methodological difficulties with sexual fluidity research. For example, it is not clear whether, statistically speaking, time and the respective reports of sexual identity, behavior or attractions interact (which is what one would expect to observe if true sexual fluidity was occurring). Moreover, any changes appear to be restricted to sexual identity labels and behavior, and less so with attractions. People with ambiguous sexual attractions at the beginning of the studies appear to be the ones reporting most change.

Insofar as the causes of sexual orientation are concerned, scientific research has focussed primarily on the traditional domains of "nature" and "nurture". However, these are not the terms that scientists usually use themselves. Causes of most human traits and conditions may, at least in theory, be reduced to genes and/or environment. Completely genetic conditions are rare and most environmental factors exert a predisposition in a particular direction, rather than explaining 100% of the variation observed. However, the sum of all the genetic and environmental variance should add up to 100%, unless there is an element of choice (as, for example, if sexual orientation is defined in terms of identity or sexual activity, rather than attraction or arousal). The term "environment" also serves to group together diverse considerations, including biological and physical factors, both in the intra-uterine environment and after birth, as well as social environment including family environment, various kinds of life events, and experiences in the wider world.

For convenience, and reflecting the primary foci of research publications, research on the causes of sexual orientation will here be considered under the headings of genetics, hormones, non-social environment and social environment.

Genetics

Two main sources of evidence are available in respect of the genetic determinants of sexual orientation: twin studies and molecular genetic marker studies.[14]

Twin studies rely on identifying differences between twins. Identical, or monozygotic (MZ), twins share 100% identical chromosomal genetic material. Non-identical, or dizygotic (DZ), twins share 50% of their genetic material in common, as do all other pairs of siblings. If a trait is genetically determined, it is therefore to be expected that MZ twin pairs will be more alike than DZ twin pairs. However, there are a variety of problems with twin studies including difficulties of systematic ascertainment of subjects, and the assumption (not necessarily valid) that MZ and DZ twins share similar environments within the home.

Studies of sexual orientation have almost all[15] shown greater similarity of MZ than DZ twin pairs, suggesting a genetic effect. The apparent effect is stronger in the earlier "targeted" studies, where recruitment of homosexual subjects was vulnerable to selection bias. In these studies, 52% of MZ twins and only 17% of DZ twins were concordant (alike) in respect of sexual orientation. In later studies (mostly undertaken using twin registers) the likelihood of sampling bias was much reduced, but concordance rates were lower: 24% for MZ twins and 15% for DZ twins. These studies allow researchers to apportion the observed variance in the trait of interest (here sexual orientation) between genetic factors, family environment (shared by the twins within the home), and specific environment (the unique and individual environmental influences that twins do not share with each other). These analyses suggest that, overall, sexual orientation in homosexual people is 32% due to genetic factors, 25% due to family environment, and 43% due to specific environment. These figures represent a modest, but not insignificant, genetic contribution to sexual orientation.

Molecular genetic techniques now allow much more sophisticated analysis, employing genetic markers available on all chromosomes, across all regions of the human genome. Unfortunately, in almost all areas of behavioral and psychiatric research, there have been problems with replication of findings. This is not entirely surprising, as most complex traits, such as sexual orientation, are unlikely to be due to a single gene. Current techniques are limited in their capacity to reliably identify effects contributed by multiple genes working in combination. There is likely also to be heterogeneity of genetic influences in the population as a whole. One gene (or group of genes) may be causally important in one family, but a completely different gene (or genes) may be important in another family.

Genetic linkage studies seek to observe whether or not genetic markers consistently segregate with the trait of interest within a given family – for example between pairs of siblings. Using this method, in 1993, Dean Hamer and his colleagues[16] found evidence for a genetic effect operating at a particular region of the long arm of the X chromosome (Xq28) in homosexual men. The finding was at first replicated by the same research group, but then an independent research group failed to replicate the results. A further study[17] by Hamer's group also failed to replicate the finding for Xq28, but did find evidence for linkage to particular markers on chromosomes 7, 8 and 10. In the most recent study of this kind,[18] the largest to date, the Xq28 finding was again replicated, as also was linkage to the region of chromosome 8 identified by Hamer's research group.

Another approach to using genetic markers is to study association between the markers and the trait of interest across the population as a whole. Much larger samples are needed here, which are not easy to recruit, and it is also necessary to identify appropriate control groups of subjects with which valid comparisons can be made. So far, only three such studies have been conducted. Drabant et al.[19] found no significant associations for male homosexuality, although the genetic region closest to significance was the same one that Hamer's research group identified on chromosome 8. Sanders et al.[20] also identified association with markers at this region of chromosome 8, and in addition with markers on particular regions of chromosomes 13 and 14. Again, this study only included males. In a recent study of almost half a million individuals (male and female) Ganna et al.[21] found evidence that same sex sexual behavior is significantly associated with five different genetic loci, only partially overlapping in males and females.

One of the puzzles in genetic research is that identical MZ twins are not always concordant for sexual orientation. A possible explanation for this, which potentially links genetic accounts of the causation with hormonal accounts (see below), is that epigenetic mechanisms are in operation whereby certain genes are "turned on" or "turned off" due to chemical changes (methylation) during development. Rice et al.[22] have provided an account of a way in which foetal sexual development may thus be impacted. At present, evidence in support of this theory is relatively limited, largely indirect, and not entirely consistent, but there is every reason to hope that future research will confirm or refute the theory.

Hormones

It is well established that physical sexual characteristics are determined by hormonal influences during early (especially intra-uterine) development. Some of these influences are reversible ("activational") and others, which occur during a critical developmental period, are not. There is some evidence that these irreversible, or "organisational", influences might include changes in the brain which determine adult sexual orientation. Whilst this evidence is subject to significant limitations, notably due to the impossibility of ethically conducting the appropriate scientific experiments on human beings, it derives from a variety of sources and, taken together, provides a body of support which cannot currently be completely dismissed.

The general principle seems to be that early exposure to higher levels of androgens (male hormones, notably testosterone), during the critical period, lead to development of male sexual characteristics. Absence of such hormonal influence is associated with the development of female sexual characteristics. Adult sexuality thus derives only indirectly from genetic (XX vs XY) sex. It is the production of androgens by the testes (found only in individuals with a Y chromosome) that makes males anatomically and behaviorally different from females. Whilst such developmental processes most commonly result in adult males who find themselves attracted to females, and adult females who find themselves attracted to males, the processes that lead to bodily anatomical and physiological sexual characteristics must clearly be distinguished from those that act upon the brain to influence experiences of sexual attraction and associated sexual behavior. It is therefore entirely possible, at least in principle, that differences in adult sexual orientation are the result of exposure of particular brain regions to atypical hormone levels during a crucial period of development.

The default developmental pathway may thus be construed as one which leads to female anatomy and adult sexual behavioral responses directed towards males of the species (androphilia). Specifically, it seems that exposure to androgens during the critical developmental "window" is associated with development instead of male anatomy and sexual behavior directed towards females (gynephilia). Is it possible, then, that variant levels of androgens acting differentially upon sexual organ development and certain brain regions during crucial periods of development might sometimes result in adult males who experience androphilia, or adult females who experience gynephilia? Evidence from animal studies, and from clinical studies of humans, suggests that this indeed might be possible.

In animal experiments, for example with mice, it is possible to expose females to higher than usual levels of androgens, and to expose males to lower levels, during early development. The result is adult females that exhibit male-typical sexual behavior, or adult males that exhibit female typical behavior, respectively. It is also possible to study sex-differences (sexual dimorphism) in brain anatomy. One particular brain region, the sexually dimorphic nucleus of the pre-optic area (SDN-POA) has been shown to be especially sensitive to perinatal androgen levels. Experiments in sheep (a good model for human homosexuality, given that a minority of rams exclusively mount other males) show that the SDN-POA is significantly smaller in those males that show androphilic rather than gynephilic adult behavior.

Clinical evidence in support of the organizational hypothesis in humans derives from several sources. Congenital Adrenal Hyperplasia (CAH), a condition associated with higher circulating androgen levels, is associated with increased rates of homosexuality in adult women. However, homosexuality is not invariable in female CAH, and there is no comparable syndrome to provide evidence that lower levels of androgens might result in male homosexuality. Sex differences in finger length ratios, specifically between length of the 2nd and 4th digits (the 2D:4D digit ratio), reflect the impact of androgens upon bone development. Homosexual women show a more masculine 2D:4D ratio than heterosexual women, but homosexual men show no differences from heterosexual men. Interesting though this is, it does not tell us anything of importance about relevant influences of androgens upon the brain.

An important and controversial study by Simon LeVay,[23] published in 1991, suggested that there are differences in the brains of homosexual men comparable to the differences in the SDN-POA which are well-established in animals. In particular, the third interstitial nucleus of the anterior hypothalamus (INAH-3) was found to be larger at post-mortem examination in heterosexual men than in homosexual men. LeVay's findings have not been replicated,[24] and the study sample was small. It would seem very unlikely that INAH-3 is the principal or sole factor determining adult sexual orientation. On the other hand, it cannot be completely excluded as evidence that the organizational hypothesis for hormonal influence upon sexual orientation does have at least some relevance in human sexual development. Strong evidence from neuroscience and neuropsychological research also suggests differences in brain organization and functioning between heterosexual and homosexual men and women. In general, this evidence shows that gay men and heterosexual women are more alike in neural correlates, while lesbian women and heterosexual men are more alike.[25]

A final and very compelling source of evidence arises from the experiences of children born male who, for medical reasons, were surgically reassigned as female immediately after birth and then brought up as girls. Such circumstances are extremely rare and medical practice has now changed, so that this state of affairs almost never pertains. However, such children were exposed to male hormonal organizational influences prior to birth, and were then exposed to female social environmental influences after birth. Studies of these children show that they almost always grow up to be gynephilic adults. It thus appears to be very difficult, if not impossible, to change male-typical (gynephilic) sexual orientation by way of manipulation of environmental influences after birth.

The non-social environment

One of the best evidenced findings in research on male homosexuality is that of the fraternal-birth-order effect (FBOE), first reported by Blanchard and Sheridan in 1992. The FBOE may be defined as "the tendency for older brothers to increase the odds of homosexuality in later born males".[26] Thus, statistically, homosexual men are more likely to have more older brothers. Older sisters do not confer the same effect, nor do older adoptive brothers or older step-brothers born to a different mother, and it does not make any difference whether the older brothers are reared together in the same family or not. Numbers of younger siblings also do not make any difference. The FBOE has been observed in widely differing cultural contexts, from North America and Europe to South America and the Middle East.

The magnitude of the FBOE is large. In men with three or four older brothers, the likelihood of homosexual orientation may be more than doubled. However, the FBOE does not explain homosexuality in first born males. The FBOE is not observed amongst females. Nor does it explain discordance for sexual orientation in male MZ twin pairs with multiple older brothers.

The evidence to date suggests that the FBOE must be due to an intrauterine environmental effect upon the developing male foetus. The most promising explanation comprises an immunological account, whereby certain, male-specific, antigens on the Y chromosome (H-Y antigens) trigger an immune response in the mother during pregnancy. Whilst this response would initially be triggered in a first pregnancy with a male foetus, H-Y antibody levels would be expected to rise in subsequent pregnancies with further male offspring. Blanchard has proposed that H-Y antibodies exert an impact on the developing brain of male foetuses in such a way as to alter sexual differentiation.[27] Recent empirical research provides some evidence in support of this hypothesis, showing that mothers of gay sons have significantly higher antibodies to neuroligin 4 (a Y-linked antigen) than do mothers of heterosexual sons.[28]

The combined body of evidence on the organizational hypothesis for hormonal influence in-utero and the FBOE suggests that non-shared environmental influences may be very significant. Thus, although approximately two thirds of the variance in adult sexual orientation appears to be environmentally determined, these influences may be largely effective prior to, or soon after, birth. They may thus also be largely non-social, due to factors affecting the early biological environment rather than later social influences.

Social environment

As noted above, the influence of social environment on biological males raised as females appears to have little or no effect upon their eventual development as heterosexual (gynephilic) adults. The combination of genetic and non-social environmental factors thus appears to have a very significant impact on eventual adult sexual orientation. Is there any evidence that this can be altered by the social environment during childhood and adolescence? Many of the theories put forward in support of the contention that it can have been associated with highly charged political, moral and theological grounds for *wanting* to believe that it can. Responses to such theories have been associated with equally highly charged and correspondingly opposed, political, moral and theological reasoning. The potential for bias in interpreting the evidence must therefore be taken into account. Randomized controlled studies that could provide definitive scientific answers would be unethical and are thus impossible to conduct. However, having noted these qualifications and biases, it may still overall be said that the scientific research that has been published suggests that the social environment does not appear to exert any impact on the development of sexual orientation.[29]

It has been alleged that young people might be recruited or seduced by homosexuals, and that this might lead them into a homosexual lifestyle when they would otherwise have grown up as heterosexual. In fact, most of the evidence concerning first sexual experience is equally, or more, amenable to interpretation on the grounds that first sexual experience is influenced by pre-determined sexual orientation. Thus, a large majority of non-heterosexual people recall experiencing same sex attraction, on average, three years before first sexual encounters.[30]

There have been various proposals that homosexuality results from problems in relationships with parents, especially the parent of the same sex, during childhood. These arise generally from a psychoanalytic tradition, based upon theories that are often not amenable to scientific testing. There is also a lack of empirical evidence that the therapies based upon these theories are effective. A key study by Bell et al.[31] found only weak and non-significant evidence for any correlation between parent–child relationships and sexual orientation. These very modest correlations would appear unlikely to have any causal significance.

There is a similar paucity of any good scientific evidence that being reared by non-heterosexual parents might affect sexual orientation. Generally speaking, in samples of families that were not systematically ascertained, there appears to be no difference in sexual orientation between children raised by heterosexual and non-heterosexual parents. In one study in which families were systematically ascertained,[32] there were small to moderate differences in the extent to which children of non-heterosexual parents self-identified as heterosexual. The difference reached statistical significance for children raised by lesbian mothers, but not those raised by gay fathers. This study has been extremely controversial and is beset with methodological problems. In any case, the cross-sectional design does not allow inference to be made about causal relationships.

There is evidence that gay, lesbian and bisexual (LGB) people (as well as people describing themselves as heterosexual but having sex with others of the same sex) are more likely to have experienced childhood sexual abuse.[33] However, current research does not provide any evidence for a causal link. Importantly, abuse could well be due to negative parental

(or other adult or peers) reactions to pre-existing indicators of later non-heterosexuality in children, namely the concept of gender non-conformity (the extent to which people engage in interests and activities typical of the opposite sex). Research does confirm that LGB adults were more likely to have expressed atypical gender preferences as children, and these differences may well provide an explanation as to why such children were preferentially singled out for abuse.[34] It is also possible that LGB adults are more likely than heterosexual adults to report abuse, although this alone is unlikely to provide a full explanation for the findings.

Summary and interpretation of the scientific evidence

To summarize briefly the literature reviewed above, there is good evidence for genetic and non-social environmental effects on sexual orientation, although more so for men than for women. There is a lack of evidence that social environment impacts significantly upon development of sexual orientation.

As Bailey et al. have noted,[35] this evidence is amenable to differing interpretation. On the one hand, it can be confidently said that a minority of people develop a homosexual orientation as adults for reasons that might largely be referred to as "nature" rather than "nurture". That is, genetic, hormonal and intra-uterine influences seem to be important, and social environment, during childhood and adolescence, does not influence adult sexual orientation. On the other hand, the lack of good scientific evidence to the contrary allows the possibility of continuing to claim that social environment, whether in family or wider society, may influence adult sexual orientation. It is always harder to prove the negative than the positive, and in general the science appears to support the former interpretation more soundly than the latter. Those who do adopt the latter account generally do so for non-scientific reasons.

Putting to one side for a moment these different possible interpretations, it is also important to recognize that the scientific perspective still understands "nurture" as a part of the natural order. Distinctions between "nature and nurture" are easily misunderstood as a contrast between what is "natural" and what human agency imposes. Influences of nurture – family upbringing, wider society, life events of various kinds – are still part of the natural order. Human life in this world cannot be conceived of without them. They may be judged adverse or beneficial to human flourishing, and they may be more or less amenable to intentional manipulation, but they are still a part of the whole system of causation that science takes into account when studying sexual orientation or, indeed, most other human traits and characteristics, as well as many physical and mental disorders. Even if "nurture" were found to be more important in the causation of sexual orientation, it would therefore still only be one part of the whole natural system of interacting variables that go to make people who and what they are. In any case, the present weight of evidence is strongly in favor of non-social, rather than social, causes of sexual orientation.

This is not to suggest that science should be understood as offering a completely deterministic account of human nature, or that the science of sexual orientation is something that completely denies human agency. Sexual orientation, understood in terms of its scientifically dissected dimensions of identity, attraction, arousal and behavior, is just one example of the wider human experience of finding that we make choices about who we

want to be, and how we live, amidst constraints of biology and environment which we can neither choose nor change. It is in this context of our experience and self-understanding, now informed by science, that Christian morality and spirituality operate. Failure to understand this can only impoverish Christian theology.

Does it matter?

It might be argued that the causes of sexual orientation are irrelevant to ethical[36] and theological debate. If homosexual acts are wrong, they are wrong regardless of the causes of homosexuality. In any case, conservative arguments typically place more weight on scripture, and less weight on scientific evidence. However, defenders of a conservative view have argued that the science supports their stance.[37] Thus, for example, Robert Gagnon presents and interprets the scientific evidence in such a way as to enable him to reach significantly different conclusions than those presented above, and then concludes that:

> The latest scientific research on homosexuality simply reinforces what Scripture and common sense already told us: human behavior results from a complex mixture of biologically related desires (genetic, intrauterine, post-natal brain development), familial and environmental influences, human psychology and repeated choices. Whatever predisposition to homosexuality may exist is a far cry from predestination or determinism and easy to harmonize with Paul's understanding of homosexuality.[38]

I have argued elsewhere that it is important to take into account what critical and peer-reviewed assessments of the scientific evidence suggest, and not to try to "make the science fit".[39] Gagnon's conclusions concerning the research (even allowing that they were published 17 years ago) do not reflect the prevailing scientific consensus, particularly in regard to the influence of social environment. However, his argument does seem to affirm that one might expect the findings of science to be in harmony with the voice of scripture. Even if theological priorities place one above the other, it would seem intuitive that the "book of nature" and the "book of scripture", if properly interpreted, should ultimately accord in their account of the truth. Theology, according to Anselm's helpful definition in the *Proslogion*, is fundamentally about "faith seeking understanding".[40] Faith and reason are mutually complementary, not contradictory.

Science is – of its very nature – always provisional. There is much that we still do not know and there is always the possibility of the current consensus being overturned by new findings. For example, the lack of evidence for social influences on sexual orientation, and the near impossibility of providing irrefutable evidence for lack of social influence, leaves scope for uncertainty. Scientists may respond to this uncertainty by undertaking different and more rigorous studies, at least within the limits of what is ethically permissible, but they must still acknowledge the weight of the extant evidence. What is known is what is probable. I would argue that theology should respond similarly. That is, theologians should acknowledge the weight of scientific evidence as it stands and reflect theologically on what is probable. However, theology has a different relationship to uncertainty than science does. If God is located within what is scientifically uncertain, and if questions of sexual orientation are understood theologically as "knowing the mind of God", then science no longer has any metric of probability to offer. If, on the other hand, the presence

and purposes of God are to be discerned in what is known – in the natural order – then science has much to tell us.

There has been much written about how to understand the proper relationship between science and theology.[41] The fundamental assumption that I am making here is that there is a constructive dialogue to be had between science and theology on the basis of a shared understanding of the meaning of reality in terms of critical realism.[42] Whilst sexuality may be a mystery in many ways, there is also much that we can know about it, and science provides one of the tools that we can use for gaining knowledge. However, this dialogue is potentially unsettling. As Salzman and Lawler have suggested,[43] it needs to include "unsafe" theologians (those who are willing to challenge ecclesial authority and traditional teaching) as well as safe theologians who use science only to support the teachings of the Church. It requires scientists and theologians to be willing to explore beyond their traditional disciplinary boundaries. It requires that experience – as well as scripture and tradition – be taken seriously as a theological resource.

Social scientific research shows that beliefs concerning the causes of sexual orientation do influence popular attitudes towards sexual minorities, usually in a more liberal and accepting direction.[44] Whilst this is an empirical finding, and professional or academic ethicists and theologians may beg to differ from popular opinion, it does at least need to be taken into account when communicating with a wider audience. Theological views of human sexuality also have impact, both on the self-understanding of LGBT people, and on wider social attitudes.[45] The social sciences have made us more aware than ever before of the ways in which scientific knowledge and theology both have an impact, for good or ill, upon human self-understanding and mental wellbeing. We therefore need to use this knowledge, and communicate it, with care.

The above review of the evidence might suggest at least four reasons for arguing that what we know scientifically about the causes of sexual orientation *is* relevant to theology and should be taken into ethical account. As indicated in the introduction, it will not be possible to pursue these here in depth, but they are proposed as important areas for further theological enquiry.

Firstly, the complexity of the scientific concept of sexual orientation, and the diversity of associated terminology, suggests that clarity and care in the use of language is likely to be important when engaging in theological discourse on the topic. Behavior, attraction, arousal and identity are different and important matters and each deserves critical theological attention. The biblical texts that are most discussed in relation to homosexuality are primarily focussed on sexual behavior. The science is primarily concerned with attraction.

Scientific terms require "translation" into biblical and theological language, and vice-versa. Words that might sound similar have different connotations in the context of scientific research. The lexicon employed in scientific definition and measurement of sexual orientation is large[46] whereas biblical scholarship has typically focussed on a relatively small number of words. A careful mapping of good and bad translations of terms would therefore seem important.[47] There is also scope for comparative theological studies in relation to non-sexual human experiences of identity, attraction and desire.[48] The research shows that our sexual attractions emerge from a complex interplay of biology and environment, and for most people are closely related to their sense of

sexual identity. In what ways (if any) does this distinguish such attractions from other things that we are drawn to, whether good or bad?

Secondly, we might note that variations in sexual orientation have scientifically understandable causes and theologically controversial[49] consequences. This state of affairs creates a significant interdisciplinary issue concerning the ways in which science and theology respectively inform our understanding of the causes and choices involved in human sexual experience and behavior.[50] It is important to acknowledge those areas over which people have choice and those over which they do not. Sexual attraction is not something that people choose to have or not to have. For the heterosexual majority, the lack of choice experienced in terms of finding others sexually attractive is traditionally contextualized by socially and ecclesially available options to marry or be celibate.[51] Tradition has not bequeathed similar options to LGB Christians, and in any case the socially and ecclesially appropriate options that might be imagined for LGB Christians are not necessarily the same as for those who are heterosexual. Marriage, in particular, is an institution that carries a considerable weight of heterosexual "baggage", and its appropriateness for LGB people is contested. Choice[52] is an important factor in ethical and theological debate and the restricted choices imposed on LGB people by biology and non-social environment should therefore be taken into account in the debate about how we wish to shape the social and ecclesial environment which impacts so significantly upon their physical and mental wellbeing.[53] There is currently no good scientific evidence to suggest that the social environment has any causal impact on sexual orientation. In contrast, there is every reason to believe that it has an impact on behavioral choices, human flourishing and wellbeing.

Thirdly, the science has implications for a theological anthropology of human sexuality. Whilst science is often perceived as challenging traditionalist anthropologies, it is not the case that this is necessarily a one way exercise of imposing discomfort on conservative theologians. Revisionists might generally point out that a focus on procreation is too narrow, and appeal more widely to human experience and the resources of science as informing a sexual anthropology. However, a critical dialogue between science and theology may legitimately challenge the norms of science as well as those of theology. It acknowledges the provisionality of both scientific and theological findings. It shifts the focus from entrenched silos of competing authority to a shared and mutually critical exercise of seeking truth. It seeks to explore the nature of sexual relationships, and sexual desire, in theological and scientific contexts.[54]

Fourthly, the scientific research raises important questions concerning what might be considered "natural" in regard to sexuality. It is fully recognized that this is a complex philosophical and theological topic.[55] Nature, like scripture, has to be interpreted and none of us come to the task without any presuppositions or prejudices. What we consider to be "natural", in a scientific sense of how we observe that things commonly are, might include a variety of things which we do not consider socially or morally acceptable, such as aggression, greed, or promiscuity. It includes diseases and disorders which, although natural, are associated with suffering and impaired function. However, nature is also "creation", the good work of a divine creator. Even if marred by sin, it still reflects something of the creative intentions of God. The crucial question here, is around the extent to which the diversity of human sexual orientation reflects the natural goodness of creation or its fall. Conservative reformed theologians may be more likely to incline to the latter view, and Thomists to the former.

Homosexual orientation is not (scientifically) observed to be directly associated with the kind of suffering that would allow it to be classified as a medical disorder, or the kind of social harm[56] that might render it to be considered immoral on consequentialist grounds. Scientific research on sexual orientation, understood purely in the light of human reason, is thus seen by most clinicians and scientists as affirming the "goodness" of natural sexual diversity. Caused largely by genetic and non-social environmental factors over which we have no control, it is just another manifestation of the enormous diversity that scientists observe to be pervasive in nature. Christian theology may have reasons for seeing things differently. For example, these particular variations in the natural order might be said to be due to original sin and "the fall", but it is not clear that they necessarily have to be seen in this way, or that this is the most convincing theological or anthropological account. Some Christians see them as reflecting the natural goodness of creation.

Biological diversity is now understood scientifically primarily within the context of evolutionary theory and sexual orientation has been no exception to this trend.[57] Evolution has presented significant challenges to Christian theology which are therefore relevant here.[58] However, the theological responses to evolutionary theory have not, thus far, been brought to bear on the debate on human sexuality. John Haught, for example, has drawn attention to the ways in which evolution suggests that God's creative humility allows a "letting be" of the world. Might we apply this to a "letting be" of sexuality, rather than trying to conform it to a humanly constrained image of what sexual orientation should look like? This is categorically not to suggest that scripture has nothing to tell us about human morality, but rather that we need to interpret scripture in the light of what science teaches us about God's creation, as well as the other way around. The "books" of nature and scripture are mutually helpful in interpreting each other.

Conclusion

Given the complexity of the issue, it would be foolish to try to reduce it all to any single underlying question. However, insofar as science gives us information about how things are observed to be, and theology seeks to understand everything in divine context, it might be said that at least one of the fundamental theological questions is about the extent to which people should be accepted "as they are". We might well debate the moral choices that people make within the context of how things are, and the extent to which Jesus did or did not expect people to change before offering them healing and forgiveness,[59] but we should not ignore the evidence before us. Sexual orientation has significant biological and non-social environmental causes which profoundly impact on our experience of ourselves and one another as sexual creatures.

Notes

1. See, for example, House of Bishops Working Group, *Report of the House of Bishops*, 97; Hays, *The Moral Vision of the New Testament*, 399. There is also an argument that such research is not relevant, regardless of how much evidence or consensus there is, simply because the moral arguments should be based on different premises, whether philosophical (Stein, "The Relevance of Scientific Research") or biblical (Hays, *The Moral Vision of the New Testament*, 398).

2. See, for example, World Medical Association, *WMA Statment on Natural Variations*, World Psychiatric Association, *WPA Position Statement on Gender Identity*, both of which premise their ethical and policy statements on the understanding of homosexuality as a normal variant of human sexuality.
3. Wilson and Rahman, *Born Gay*; LeVay, *Gay, Straight, and the Reason Why*; Bailey et al., "Sexual Orientation, Controversy, and Science"; Roselli, "Neurobiology of Gender Identity."
4. See, for example, American Psychological Association, *Key Terms and Concepts in Understanding*.
5. Bailey et al., "Sexual Orientation, Controversy, and Science."
6. Bullough, "Sex Will Never Be the Same."
7. Where sexual identity is defined according to experienced sexual orientation, it is debatable whether in fact sexual identity is a matter of "choice". One can, for example, choose to identify as heterosexual despite a strong sense of attraction to others of the same sex and a lack of interest in the opposite sex, but this is more about willingness to accept the implications of a particular social identity, rather than "choice" in the sense intended here. Of course, choice can be exerted in relation to identity in certain ways, such as an eschewal of an overtly gay lifestyle, or a decision to make personal identity dependent more on other priorities, such as identity "in Christ". To this extent, sexual identity is a matter of choice.
8. Savin-Williams et al., "Prevalence and Stability of Self-reported." See also LeVay, *Gay, Straight, and the Reason Why*, 9–12.
9. American Psychological Association, *Report of the American Psychological Association*.
10. Diamond, "A New View Of Lesbian Subtypes"; Diamond, *Sexual Fluidity*; Diamond, "The Desire Disorder in Research"; Dickson et al., "Stability and Change in Same-sex Attraction."
11. Baumeister, "Gender Differences in Erotic Plasticity"; Diamond, *Sexual Fluidity*.
12. Diamond, *Sexual Fluidity*.
13. Diamond, "Was it a Phase?"
14. Bailey et al., "Sexual Orientation, Controversy, and Science," 74–7; LeVay, *Gay, Straight, and the Reason Why*, 157–79.
15. In one study, no difference was found.
16. Hamer et al., "A Linkage between DNA Markers."
17. Mustanski et al., "A Genomewide Scan of Male Sexual Orientation."
18. Sanders et al., "Genome-wide Scan Demonstrates Significant."
19. Drabant et al., *Genome-Wide Association Study of Sexual Orientation*.
20. Sanders et al., "Genome-Wide Association Study of Male Sexual Orientation."
21. Ganna et al., "Large-scale GWAS Reveals."
22. Rice et al., "Sexually Antagonistic Epigenetic."
23. LeVay, "A Difference in Hypothalamic Structure."
24. In the only published attempt at replication to date, a non-statistical trend in support of LeVay's findings was reported (Byne et al., "The Interstitial Nuclei of the Human Anterior Hypothalamus"). These studies were made possible by the unusually large number of post-mortem examinations of gay men conducted at the height of the HIV epidemic and further attempts at replication would now be extremely difficult to undertake. See reviews by Bailey et al., "Sexual Orientation, Controversy, and Science," 71–2, and LeVay, *Gay, Straight, and the Reason Why*, 195–201.
25. Savic and Lindström, "PET and MRI Show Differences in Cerebral Asymmetry"; Xu et al., "Sexual Orientation and Neurocognitive Ability."
26. Blanchard, "Fraternal Birth Order, Family Size, and Male Homosexuality."
27. Blanchard and Klassen, "H-Y Antigen and Homosexuality in Men."
28. Bogaert et al., "Male Homosexuality and Maternal."
29. See review by Bailey et al., "Sexual Orientation, Controversy, and Science," 80–6.
30. Bell et al., *Sexual Preference: Its Development in Men and Women*.
31. Ibid.
32. Regnerus, "How Different are the Adult Children."
33. Sweet and Welles, "Associations of Sexual Identity."

34. Bell et al., *Sexual Preference: Its Development in Men and Women*; Xu and Zheng, "Does Sexual Orientation Precede Childhood Sexual Abuse?"
35. Bailey et al., "Sexual Orientation, Controversy, and Science," 87.
36. See, for example, Greenberg and Bailey, "Do Biological Explanations of Homosexuality", who argue, at least, that the relationship is not straightforward.
37. See, for example, O'Callaghan and May, *Beyond Critique*; Jones and Yarhouse, *Homosexuality*.
38. Gagnon, *The Bible and Homosexual Practice*, 430.
39. Cook, "Science and Theology in Human Sexuality."
40. Davies and Evans, *Anselm of Canterbury*.
41. See, for example, Barbour, *Nature, Human Nature, and God*; Polkinghorne, *Science and Theology: An Introduction*.
42. For a helpful account of such an approach, see Salzman and Lawler, "Theology, Science, and Sexual Anthropologies," 74–7.
43. Ibid.
44. Sheldon et al., "Beliefs about the Etiology"; Haider-Markel and Joslyn, "Beliefs About the Origins of Homosexuality and Support For Gay Rights"; Garretson and Suhay, "Scientific Communication about Biological Influences."
45. Bradshaw et al., "Religious Experiences of GBTQ Mormon Males"; Cerbone and Danzer, "The Case of Abel."
46. Sell, "Defining and Measuring Sexual Orientation."
47. There has of course been considerable attention to the biblical terminology, but generally not a critical engagement of this with the corresponding scientific terminology. See, for example, House of Bishops Group on *Issues in Human Sexuality*, *Some Issues in Human Sexuality*, 130–44; Martin, *Sex and the Single Savior*, 37–50; Burridge, *Imitating Jesus*, 128; Loader, *The New Testament on Sexuality*, 293–338.
48. See, for example, Cook, *Alcohol, Addiction and Christian Ethics*; Cook, *The Philokalia and the Inner Life*.
49. I imply no value judgement here. I simply observe that the matter *is* controversial – whether it should be or not.
50. Cook, "Science and Theology in Human Sexuality."
51. I am aware that statistics show that increasing numbers of young heterosexual Christians do not feel constrained by these options. This does not appear to have evoked the same level or kind of controversy within Christian churches as the debate concerning homosexuality.
52. It might be argued that we may not exercise choice over matters that are construed as subject to divine command. That is, LGB people can choose to live in faithful and loving sexual relationships with one another but only by going against a divinely imposed moral law. Society can choose to be more permissive and supportive of LGB rights, but only by going against what God has ordained. This takes us away from the scientific research to theological debates concerning revelation of God's will and ethical debates concerning deontological and consequentialist grounds for moral reasoning. However, even if such a view is accepted, the science is still relevant to the moral debate insofar as it identifies material (scientific) reasons why certain people might be more predisposed towards certain behaviors deemed immoral than are others.
53. There is a significant scientific literature on this topic, which is addressed elsewhere. Generally, the stigma and discrimination experienced by LGBT people are associated with poorer health status. See, for example, Mundle et al., "Homosexuality and Mental Health"; Semlyen et al., "Sexual Orientation and Symptoms"; Timmins et al., "Minority Stressors, Rumination". Research also suggests that marriage is associated with better health (Kealy-Bateman and Pryor, "Marriage Equality is a Mental Health Issue.").
54. Again, Salzman, and Lawler, "Theology, Science, and Sexual Anthropologies", provide a helpful analysis of some of the issues.
55. The concept of nature is a socially constructed one, and is susceptible to a variety of different definitions. This issue is explored, for example, by McGrath, *A Fine-Tuned Universe*, in his Gifford Lectures.

56. Much is alleged in this regard, but empirical evidence to support such contentions of harm is generally lacking.
57. Roughgarden, *Evolution's Rainbow*; Roughgarden, "Homosexuality and Evolution."
58. Edwards, *The God of Evolution*; Haught, "God and Evolution."
59. This is helpfully reviewed by Burridge, *Imitating Jesus*, 69–73.

Acknowledgement and Disclaimer

Professor Cook was a member of the Social and Biological Sciences Thematic Working Group, which was one of a number of thematic groups working under the aegis of a Coordinating Group as a part of the Living in Love and Faith project on Human Identity, Sexuality, Relationships and Marriage for the Church of England. The views expressed in this paper are entirely his own. They do not reflect the views of the Working Group or of LLF. However, thanks are offered to other members of the group for critical and constructive conversations which have played a formative part in the writing of this paper.

Disclosure statement

No potential conflict of interest was reported by the author.

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